DOCUMENT RESUME

ED 102 967 IR 001 649

AUTHOR Brooke, Martha L.; And Others
TITLE A Team Approach to Developing an Audiovisual Single-Concept Instructional Unit.
INSTITUTION American Physiological Society, Bethesda, Md.
PUB DATE Jul 74
NOTE 8p.
JOURNAL CIT The Physiology Teacher; v3 n3 Jul74

EDRS PRICE MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS Audiovisual Aids; Biological Sciences; Biology Instruction; Cardiovascular System; *Educational Television; Film Production Specialists; Instructional Media; Media Technology; *Medical Education; *Production Techniques; *Single Concept Films; Teamwork; Units of Study (Subject Fields); Video Cassette Systems; Video Tape Recordings
IDENTIFIERS National Medical Audiovisual Center

ABSTRACT

In 1973, the National Medical Audiovisual Center undertook the production of several audiovisual teaching units, each addressing a single-concept, using a team approach. The production team on the unit "Left Ventricle Catheterization" were a physiologist acting as content specialist, an artist and film producer as production specialist, and an education specialist. After educational objectives for the film were written, a storyboard was drawn up for a translation into film. A prerequisite test, pretest, and posttest were written for the unit. Before filming, the final storyboard and script were critiqued by students and additional revisions were made. Filming and editing took a relatively short time. The production was then field tested and found to be an effective instructional device. The systematic team approach to instructional media development was judged an effective strategy for media production, as it required a pooling of the varied talents of team members. (KC)

ED102967

Reprinted from:
The Physiology Teacher
Vol. 3, No. 3, July 1974

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A TEAM APPROACH TO DEVELOPING AN AUDIOVISUAL SINGLE-CONCEPT INSTRUCTIONAL UNIT

By: Martha L. Brooke, Richard W. Bell and Morton J. Oppenheimer
National Medical Audiovisual Center, Atlanta, Georgia

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National Audiovisual Center, Atlanta, Georgia

In 1973 at the National Medical Audiovisual Center (NMAC) in Atlanta, a component of the National Library of Medicine, the production of several audiovisual teaching units was undertaken with two specific goals in mind. The first goal was that the content of each unit address a *single concept;* the second goal was that the units be developed using a *team approach.* A single concept was specified as a fundamental block of knowledge with an apparent beginning and end, though it might be only one of a series of such "knowledge blocks" necessary for total understanding of a given subject. Such a single-concept teaching unit would generally not exceed fifteen minutes. Being a discrete body of information, the unit could be applicable to a number of different areas of study. The team approach specified in the second goal called for a shifting style of leadership. Leadership of the project shifted at various stages among three cooperating specialists: a Content Specialist, an Education Specialist, and a Production Specialist. Use of the team approach was important because the collective input of three specialists would provide a body of expertise not ordinarily found in one individual.[1]

This discussion describes a project that was developed by such a team. The Content Specialist was M. J. Oppenheimer, M.D., a Physiologist. Before coming to the National Medical Audiovisual Center, Dr. Oppenheimer had had 40 years of teaching experience at Temple University School of Medicine, the last twenty years as Chairman of the Physiology Department. The Education Specialist was Martha Brooke, who had had experience as an education media designer in a variety of settings, including schools of medicine and nursing. The Production Specialist was Mr. Rick Bell, an artist and production director, who had worked extensively in animated film.

The final product was a 2-inch videotape master entitled LEFT VENTRICLE CATHETERIZATION.* This was based on some existing ½ inch video footage supplied by the Content Specialist. Dr. Oppenheimer had filmed assorted sequences of retrograde left ventricle catheterization of dogs. The catheterization process is monitored in the laboratory by X ray, with the image displayed on an image-intensifier screen. The video footage was obtained by training a small video camera on the screen. This footage was the basis for our single-concept unit using the team approach.

PROCEDURE

The three members worked together on a procedure which was composed of five Developmental Stages:

I. Specify Teaching Problem
II. Design Learning Experience
III. Critique Storyboard
IV. Produce First Edition
V. Assess Effectiveness

Figure 1 presents these five Developmental Stages comprising Eleven Steps. The Eleven Steps began with concept selection by the Content Specialist and ended with student assessment of the final production; Figure 1 is also shade-coded, indicating the shift of input/decision-making responsibility among the three specialists for each of the Eleven Steps. White indicates Content, light gray, Education, and darker gray, Production.

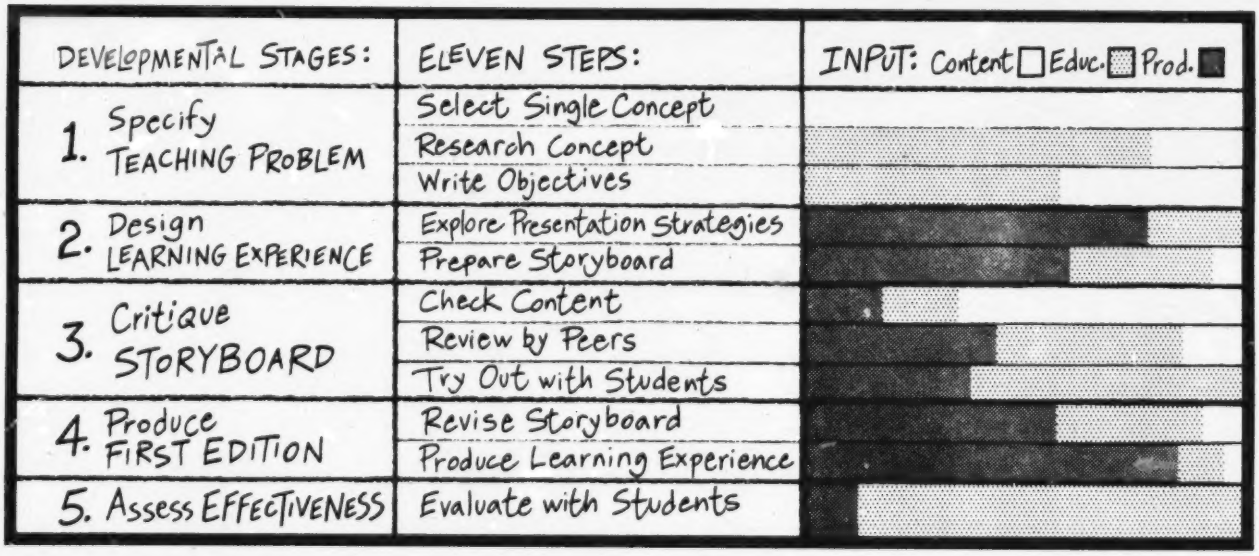

Fig. 1. Five Developmental Stages comprising Eleven Steps. The leadership input of each specialist is shade-coded for each of the Eleven Steps: white—Content Specialist; light gray—Education Specialist; darker gray—Production Specialist.

*LEFT VENTRICLE CATHETERIZATION—NMAC order number T-2838 (tape or film, 16mm motion picture). For specific order information concerning MP loan or MP and videotape purchase, write NMAC, Atlanta, Georgia 30333, for brochure.

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The first Developmental Stage was "Specify the Teaching Problem." This stage included three steps: *select a single concept, research the concept,* and *write objectives* for it. In the first step, Dr. Oppenheimer studied his half-inch videotape plus various physiology references to determine what he considered to be the most appropriate fundamental concept for the project. He decided upon the physiological relationship involving aortic valve, left ventricle, and catheter during the process of retrograde left ventricle catheterization. Having *specified the single concept,* Dr. Oppenheimer gave Miss Brooke, the Education Specialist, a number of references[2-5] to use in *researching this concept.* The Education Specialist used the literature references as part of a tutorial relationship with the Content Specialist. In this manner, Miss Brooke not only studied catheterization of the left ventricle, but also expanded her knowledge with study of the general area of cardiovascular structure and function.

The value of this study became apparent in the next step within the "Specify the Teaching Problem" stage, the *write objectives* step. As a result of her background study, the Education Specialist was able to participate in a more meaningful dialogue with the Content Specialist. In this project an "objective" was defined as a behaviorally stated teaching/learning goal. That is, an objective not only specified the subject-matter content; it also described how the student would be able to demonstrate or use the content.

In this objective writing step, Miss Brooke and Dr. Oppenheimer decided upon a General Objective: "Given an X-ray image of retrograde left ventricle catheterization of a canine heart, the student will be able to describe the conditions that enable the catheter to enter the ventricle." (Stated technically, these conditions are that the aortic valve is open only during the ejection period of the ventricle; this event allows a catheter to pass, against the direction of blood flow (retrograde), into the ventricle from the aorta.) The General Objective contained three subobjectives which, stated briefly, were: identify X-ray boundary landmarks; identify relevant dye-visualized cardiovascular structures; and describe the dynamic relationships of the valve, ventricle, and catheter. The three subobjectives comprised over twelve specific responses. Thus, the General Objective for one single concept contained more than a dozen specific *responses* (see Figure 2).

GENERAL OBJECTIVE	SUBOBJECTIVES	SPECIFIC RESPONSES
Given an x-ray image of retrograde left ventricle catheterization of a canine heart, the student will be able to describe the conditions that enable the catheter to enter the ventricle.	IDENTIFY x-ray boundary landmarks	1. Left Ventricle 2. Inferior Vena Cava 3. Diaphragm
	IDENTIFY relevant dye-visualized cardiovascular structures	1. Left Ventricle 2. Aortic Valve 3. Sinus of Valsalva 4. Aortic Arch 5. Descending Aorta
	DESCRIBE the dynamic relationships of the valve, ventricle, and catheter	1. ventricle - DIASTOLE valve - CLOSED catheter - DEFLECTED 2. ventricle - SYSTOLE valve - OPEN catheter - ENTERS

Fig. 2. Breakdown of General Objective into three Subobjectives and subsequently into over twelve specific responses.

The general and subobjectives specified not only the subject-matter content but, in behavioral terms, how the student would be able to demonstrate or use that content. The subobjectives called for *identify* and *describe* types of behavior. Here's an example of "identify" type of behavior: "Show me a xylk."—"Ah! There's a xylk!" This type of behavior (e.g., "identify") is most appropriate for a visual learning experience because it makes the visual image, not the printed word, the essence of the learning experience.

The second Developmental Stage (Figure 1) was "Design the Learning Experience." Within this stage there were two steps: first, *explore presentation strategies;* then, *prepare the storyboard.* The instructional objectives had been previously specified. Now the audiovisual medium that would be used to elicit the desired student responses (i.e., the instructional objectives) needed investigation.

There was one "given" to work with—the existing ½ inch videotape footage of canine catheterization. In reviewing that footage it was found that it contained dye injection sequences which necessitated motion for the required visual comprehension. Thus motion became a second "given." In subsequent brainstorming explorations of possible teaching strategies, it was further determined that the use of some sort of "freeze-frame" device would be very desirable at certain key points in the action. All of these requirements could be handled in either the motion-picture or TV medium. The choice hinged on the need to retain maximum quality of the X-ray image in the final product. After discussions with both TV and film consultants, it was decided that TV would be the most suitable production medium. With this decision made, Mr. Bell and the TV staff explored in greater depth the utilization possibilities of the initial ½ inch videotape footage. This presentation strategy exploration was most helpful because some design ideas were ruled out as unrealistic. But, more importantly, the TV specialists provided ideas for other uses of the TV medium which were incorporated in the final production design.

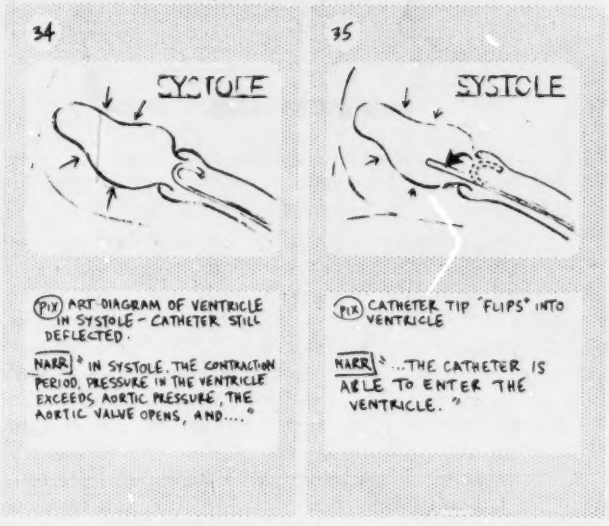
34
SYSTOLE
PIX ART DIAGRAM OF VENTRICLE IN SYSTOLE - CATHETER STILL DEFLECTED.
NARR "IN SYSTOLE, THE CONTRACTION PERIOD, PRESSURE IN THE VENTRICLE EXCEEDS AORTIC PRESSURE, THE AORTIC VALVE OPENS, AND...."
35
SYSTOLE
PIX CATHETER TIP "FLIPS" INTO VENTRICLE
NARR "...THE CATHETER IS ABLE TO ENTER THE VENTRICLE."

Fig. 3. Example frame of the storyboard with *visual, PIX* (picture) description of pictorial requirements, and *NARR* (narration) for each visual thought.

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For the next step, *preparing the storyboard,* the Production and Education Specialists sat down with two key elements to build on: the instructional objectives, and a knowledge of the TV capabilities at their disposal.

A storyboard is a tool for planning visual presentations. It is made up of a sequence of picture panels which at first glance resembles a comic strip. Each panel contains a drawing of some key point in the proposed visual content. Underneath the drawing is a brief description of pictorial requirements plus accompanying narration. Each significant visual change in the planned production requires a new storyboard panel. (See example of panels in Figure 3.) A completed storyboard becomes the master plan for a visual production.

Although preparation in this team approach was principally the responsibility of the Production and Education Specialists, the progress of the storyboard especially benefited from the availability and interest of the Content Specialist, who was a most valuable reference/interpreter.

The storyboard for Left Ventricle Catheterization was more than just a series of show-and-tell pictures with accompanying narration. It was an underlying master scheme (see Figure 4). The overall scheme of this production called for three tests: the prerequisite test, the pretest, and the posttest. All three were used for evaluating the instruction during the developmental process. Only the posttest was included in the final distributed unit.

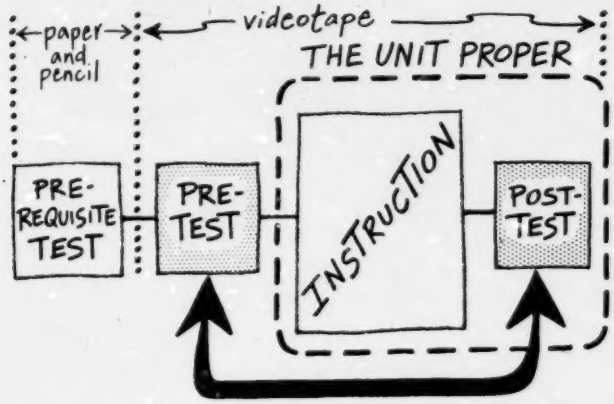

Fig. 4. Master scheme of total project: paper and pencil prerequisite test; videotape pretest and unit (instruction and modified posttest).

The prerequisite test was a paper and pencil test, designed to assess the student's assumed preparatory knowledge or level of entrance, in this instance, knowledge of basic left heart structures and functions. Both the pretest and the posttest, like the instruction, were storyboarded and produced on videotape. They were essentially the same test, drawn directly from the instruction. The final distributed unit consisted only of the instruction and the posttest. Since answers were provided to the posttest, it functioned in the unit as a review.

The storyboard was developed with a specific structure in mind for the unit proper (i.e., the instruction and the posttest). Figure 5 shows that the unit proper contained essentially four parts: orientation, objectives, body, and test. The orientation section introduced the topic of left ventricle catheterization, introduced the canine "patient," located the X-ray hardware around the dog, and oriented the student to the anatomical view of the dog in the X-ray field. The next section presented the three instructional objectives: identify X-ray landmarks; identify relevant dye-visualized cardiovascular structures; and describe the dynamic relationship of valve/ventricle/catheter. Having introduced the instructional objectives, the unit proceeded into the body of instruction. The body of instruction was *directly related to* each objective. For example, in storyboarding for the first objective of "identify X-ray landmarks" the visual and verbal *information* were first given. Then the student used the information in a *response.* Finally, the student was given a *feedback* answer to his response. To look at this three-part format in more detail, the X-ray landmarks to be identified for the first objective—the diaphragm, left ventricle wall, and Inferior Vena Cava—were presented in graphics, X-ray image, and narration as *information.* Then, for a *response,* the student was asked to study an X-ray and ascertain which of the three landmarks presented the faintest image. Finally, in the *feedback* answer, the Inferior Vena Cava was specified as the faintest while the diaphragm and left ventricle were also identified with labels and verbal reinforcement. This three-part format—*information, response, feedback*—was applied in the body of instruction to each of the three objectives.

Finally, the review test was constructed. The test was taken directly from the objectives and from the body of instruction (see Figure 5). In this case, for each objective the *response* and *feedback* parts from the body of instruction were repeated to

ORIENTATION	OBJECTIVES	BODY	TEST
Topic "Patient" Hardware Anatomy	I. LANDMARKS	• Information • Response • Feedback	Response Feedback
	II. STRUCTURES	"	"
	III. RELATIONSHIPS	"	"

Fig. 5. The four-part internal structure of the unit proper: orientation, objectives, body, and test.

create the review test. Again, this was done for all three objectives. In summary, the unit as it appeared on the storyboard had a general orientation and an internal consistency throughout the objectives, the body of instruction, and the review test.

With the initial storyboard completed by efforts of all three specialists, work continued into the third developmental stage—"Critique the Storyboard." The three steps involved in this critiquing stage called for evaluations from three categories of critics. First—check out the stoyboard with the *Content Specialist;* second—review it with content *peers;* and third—try it out with *students,* the target consumer. The Content Specialist's critique was tremendously helpful in ironing out inconsistencies and stumbling blocks. Help was especially

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needed to find correct wording. For instance, a word was needed to describe systole and diastole of the left ventricle. Dr. Oppenheimer helped the Production and Education Specialists identify the term "ventricular period." Although this step in the system represented the Content Specialist's "formal" critique, Dr. Oppenheimer also supplied informal critiques throughout the storyboard development, aiding immeasurably in keeping the evolving unit on target. After the *Content Specialist's* review, content *peers* (e.g., M.D.'s, physiology professors) provided more feedback on the storyboard. In the third step, a number of *students* critiqued the storyboard. With all three critic groups—Content Specialist, content peers, and students—the Production Specialist would individually talk each critic through the storyboard while the Education Specialist recorded their spontaneous responses. Then after this initial experience with the storyboard, the Production and Education Specialists would sit down with the individual critics and go over the whole storyboard again with a fine-tooth comb. The critics were asked not to be polite "nice guys." Rather, each one was asked to share any and all of his thoughts about how the unit seemed to work; or, more importantly, his personal view of what portions seemed *not* to work. This would include not only thoughts about the technical approach to content, but also any emotional reaction to the design and flavor of the unit. The whole review process with the Content Specialist, content peers, and students was an extremely important step, and without a doubt a valuable learning experience for the principal storyboard designers—the Production and Education Specialists.

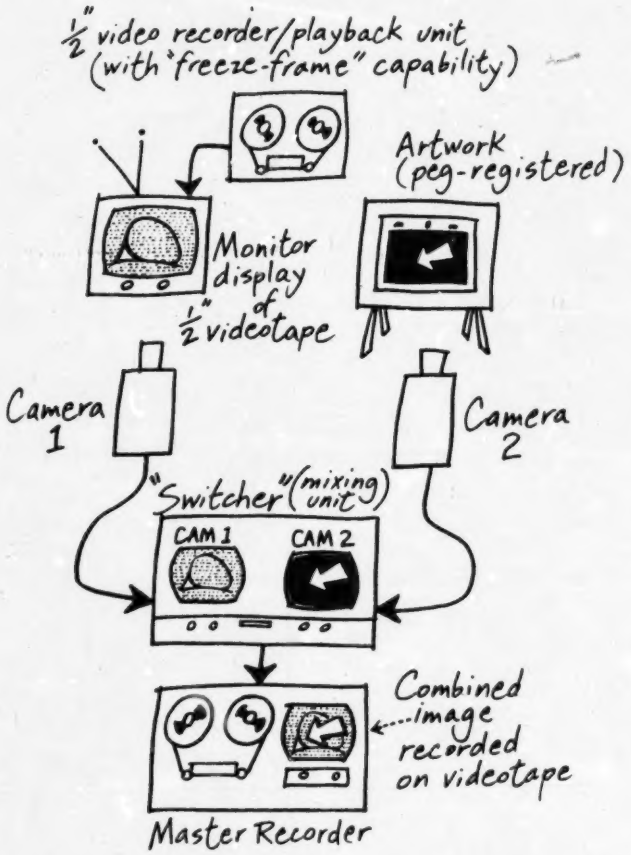

Fig. 6. Use of two cameras to mix X-ray and artwork images together to form the recorded image of the editing master videotape.

This learning experience was then used in the next Developmental Stage, which was "Produce the First Edition." This stage involved two steps: first, *revise the storyboard;* and second, *produce the learning experience.* Using the suggestions gained during the "Critique" Developmental Stage, the Production and Education Specialists began digging into the revision step. Although this revision work can be tedious and time consuming, it is also very rewarding; and finally, a storyboard revision does get the "O.K." by all three team specialists. In the next step, when the learning experience is actually produced, the Production Specialist shoulders a great amount of work and responsibility.

To *produce the learning experience,* Mr. Bell first worked with a dupe of the original ½ inch videotape X-ray footage, making "freeze-frame" tracings of key scenes from a monitor screen. These tracings were used to produce graphics and titles which would eventually be superimposed over the selected scenes. Then he produced the other graphics—drawings of the dog, labels, etc. Having completed the artwork needed to fulfill the specifications of the storyboard, Mr. Bell then directed the process of mixing together the original X-ray footage and this artwork onto a two-inch editing master videotape. Because of electronic signal incompatibility in the equipment, the ½ inch videotape could not be fed directly into the 2-inch master. Therefore, to produce the editing master, two TV cameras were used (see Figure 6). One camera was trained on a small-screen TV monitor which would play the original ½-inch videotape. The half-inch playback unit feeding the monitor also provided the necessary "freeze-frame" capability. A second camera was trained on registered graphics that could be used to produce superimposed images onto the X-ray footage picked up by the first camera. A major key to this production was this use of registered graphics to produce animation and superimposition effects, especially the superimposed images on X-ray footage.

All of the necessary scenes and scene fragments were recorded onto the 2-inch videotape editing master. The sequence of recording at this stage was determined by production convenience rather than story continuity, and all scenes were recorded over-length for subsequent editing. Finally, this editing videotape master and a previously recorded professional narration on ¼-inch audiotape were edited together in proper sequence to create the finished 2-inch videotape master product—Left Ventricle Catheterization. There were over a hundred shots or cuts to this production. The final editing took only a day and a half, making it a joy to see the finished unit unfold so quickly. Credit for this time-saving and rewarding final editing experience should go to the expertise of the TV production staff coupled with the detailed planning and production documentation on the part of the Production Specialist.

The product was then used in the fifth Developmental Stage of "Assess Effectiveness." This, of course, called for *evaluation with students,* who participated in the evaluation process individually. The Education Specialist asked each student to first take the paper and pencil prerequisite test and then go through the video experience, which included the pretest, the instruction itself, and the posttest. Responses in this

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finished video learning experience were designed to be covert. That is, the student reacts to question "in his head" as opposed to an overt response which would be observable behavior. However, for the purposes of validating the product, the student was asked to respond aloud so that an observer could record his responses. After taking the tests and going through the learning experience, the student discussed the product with the Education Specialist and Production Specialist. They used the storyboard to help pinpoint specific areas for which he had suggestions and criticisms. Five students participated in the production's initial evaluation. Figure 7 is a tally of their responses on the pre- and posttests. The tally marks represent correct responses. Incorrect responses or instances of no response are not shown. On the pretest, several students recognized a number of the dye-visualized cardiovascular structures. A 100% score was attained by all students on all responses in the posttest.

It should be noted that there are certain parts within this eleven-step system which seem to establish the essential character of the procedure. These essential parts are: the *research*

CORRECT RESPONSES	PRE-TEST	POST-TEST
LANDMARKS:		
Left side---DIAPHRAGM		𝍸
Lower side--INFERIOR VENA CAVA		𝍸
Right side--LEFT VENTRICLE		𝍸
CARDIOVASCULAR STRUCTURES:		
LEFT VENTRICLE	III	𝍸
AORTIC VALVE	I	𝍸
SINUS OF VALSALVA	II	𝍸
AORTIC ARCH	II	𝍸
DESCENDING AORTA	I	𝍸
CATHETER CANNOT ENTER:		
Catheter----------DEFLECTED		𝍸
Aortic valve--------CLOSED		𝍸
Left Ventricular Period--DIASTOLE		𝍸
CATHETER CAN ENTER:		
Catheter----------ENTERED		𝍸
Aortic Valve--------OPENED		𝍸
Left Ventricular Period--SYSTOLE		𝍸

Fig. 7. Tally of responses on pre- and posttests of the five students participating in the unit's initial evaluation.

the concept step; the *explore presentation strategies* step; and the *storyboard critique and revision* process (see Figure 8). At each of these points the team members paused in their single-minded pursuit of an instructional medium product to engage in a three-part creative process. They would first investigate resources other than themselves, then review the full range of ideas, and finally distill the ideas to arrive at suitable choices.

The investigation of outside resources is not meant to imply that the team members did not have their own initial thoughts about the project at hand. Rather, the team's thinking was periodically appraised in the light of other source material. Such appraisals should be undertaken with a genuine openness to possible revision of current thoughts; that is, outside resources should not be sought for the self-serving goal of confirming the team's own thinking. For example, during the storyboard critique/revision process it was essential to remain receptive to some hard-to-take criticism. In fact, certain parts of the initial storyboard were completely dismantled—and a better production plan resulted. (It might be added that the Production and Education Specialists are thankful that they *did not* produce their first thoughts.)

This concludes this overview of the five Developmental Stages with their eleven steps. It took four months to complete this project; that is, to go through the eleven steps. How-

DEVELOPMENTAL STAGES:	ELEVEN STEPS:
1. Specify TEACHING PROBLEM	Select Single Concept
	Research Concept
	Write Objectives
2. Design LEARNING EXPERIENCE	Explore Presentation Strategies
	Prepare Storyboard
3. Critique STORYBOARD	Check Content
	Review by Peers
	Try Out with Students
4. Produce FIRST EDITION	Revise Storyboard
	Produce Learning Experience
5. Assess EFFECTIVENESS	Evaluate with Students

Fig. 8. Steps which establish the essential character of this eleven-step system: the *research the concept* step, *explore presentation strategies* step, and the *storyboard critique and revision* process.

ever, a straight bar graph of time would not adequately represent man-hours. Shades of gray give a better indication of the time involved (see Figure 9). For instance, at the beginning of the project, possibly one or two people devoted one or two hours a day; whereas, toward the end of the project, one to eight people devoted eight hours a day.

It would be appropriate to mention that the time necessary for a unit varies with the visual problem of the content and the subsequent type of AV media produced. More specifically, motion visuals have different visual problems than still shots, and the difficulty encountered can vary enormously with the requirements of content.

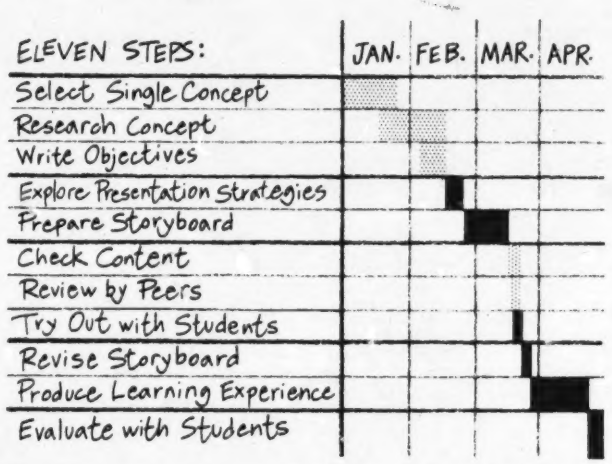

Fig. 9. Bar graph of time span and man-hours involved in project production. Light gray—1-2 persons working 1-2 hours a day; medium gray—1-2 persons, 4-8 hours; and dark gray—1-8 persons, 6-8 hours.

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DISCUSSION

In summary, we would like to share some thoughts about this systematic approach.

First of all, the system was *prestated,* and even though this process was a new experience for the individuals, all three members of the team did have in mind the eleven steps from the very beginning of the project. As the process progressed, each member knew where the unit stood at any given stage of development. This knowledge enabled each specialist to anticipate and schedule his own input responsibilities. Such a perspective allowed each specialist to know when his input would be of critical importance and when his role was more of a supportive one. This visible delineation of responsibilities promoted integration of three professional specialists into a proficient team.

The eleven-step system was *loosely defined.* Each step was stated as an activity, and the specialist(s) primarily responsible for that activity was indicated. The method of executing each step was left open. By not being rigidly specified, the system gave each of the three specialists license to "practice his art," to retain his professional identity within the team, and to have this identity reflected in the team's product.

Besides the virtues of having a system that is prestated, this team has noted several other keys to the development of Left Ventricle Catheterization. First, each of the three specialists was a "naive subject" in this production endeavor. The eleven-step system employed was not a jealously protected "baby" of any one of the team members. In this case, the system was suggested by the Office of the Director at NMAC. Thus, each of the three specialists was on equal footing in a mutual venture.

Another key to the successful use of the system was the fact that one of the team members (i.e., Miss Brooke, the Education Specialist) was also the producer/project officer. It should be emphasized that even within the team approach, which is based on shifting leadership among three specialists, it is both advantageous and important to have one of the individuals designated as having producer responsibilities such as budget, schedules, and official forms. Otherwise, without one individual as a central reference point, necessary considerations may easily be overlooked or delayed.

The talents represented on this team are not peculiar to NMAC. They are present in most academic settings, especially schools of medicine. Nevertheless, even where areas of content authority, educational technology, and media production exist side by side, lines of communication among them may remain undeveloped. Thus the prospects of a cooperative venture can cause some apprehension in all quarters. This team, however, found that a systematic approach can be an "ice breaker" for integrative utilization of these specialities.

Even so, the authors are not so single minded as to maintain that this system or any other is a panacea for all production and group-effort problems. Indeed, the team did not function smoothly at all times during this first experience with the system. The initial try was definitely a "feeling out" process, adjusting to both the systematic approach and the personalities of the individuals involved.

In closing, we have found that both the team and individuals benefited from a systematic team approach to instructional media development. We realize that it is difficult for one individual to possess all the talents, experience, time, and energy necessary to carry to completion a product of desired quality.

The team feels that the product Left Ventricle Catheterization reflects cooperative input, and that they as individuals gained in knowledge of instructional media development by this pooling of efforts. The authors are currently at work on a new teaching unit concerning right heart catheterization.

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